Federal Communications Commission

BEFORE THE

In the Matter of	)	
	)	
Amendment of Section 2.106 of	)	ET Docket No. 92-28
the Commission's Rules to	)	RM-7771 PP-29 PP-32
Allocate the 1610-1626.5 MHz	)	RM-7773 PP-30 PP-33
and the 2483.5-2500 MHz Bands	)	RM-7805 PP-31
for Use by the Mobile-Satellite	)	RM-7806
Service, Including Non-	)	
geostationary Satellites	)	

To the Commission:

CELSAT PETITION FOR RECONSIDERATION

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To the Commission:

CELSAT PETITION FOR RECONSIDERATION

CELSAT, Inc., petitioner in RM-7927, pursuant to Section 1.429 of this Commission's Rules, hereby seeks reconsideration of the Commission's *Notice of Proposed Rule Making and Tentative Decision* released in the above-captioned proceeding on September 4, 1992.[1] In support thereof, CELSAT states as follows:

SUMMARY

CELSAT seeks reconsideration of the Commission's partial dismissal of its petition for an HPCN rule making to the extent that the Commission incorrectly understood CELSAT's geostationary system (GEO) to be incapable of spectrum sharing with the low earth orbit (LEO) system proposals, and to the extent the Commission

[1] Although CELSAT's petition for rule making in these bands was designated RM-7927, and although the Commission's NPRMTD purports to dismiss CELSAT's petition to the extent it relates to the subject RDSS L/S-Bands, "RM-7927" does not appear in the caption of the Commission's order.

perceives CELSAT's HPCN concept to be inconsistent with the WARC-92 re-allocation of the 1610-1626.5 MHz and 2483.5-2500 MHz bands for the United States. Because CELSAT proposes CDMA modulation and a very high gain satellite antenna, its particular GEO system is fully capable of sharing the L/S-Band spectrum with LEO systems. (The GEO systems of AMSC and INMARSAT, however, cannot share, as the Commission correctly noted.)

CELSAT's HPCN operation in the subject band, either as initially proposed or as slightly re-configured, will not be inconsistent with the WARC-92 re-allocation. First, it is not necessary that CELSAT use spectrum subbands from within the proposed new MSS allocation to service its HPCN terrestrial component. To the extent now required by sharing and the new WARC-92 restrictions, CELSAT will turn elsewhere for its terrestrial component. Second, however, even if subbands within the new MSS allocation were used as originally proposed, technical compliance with the WARC-92 re-allocation could still be attained within the U.S.

Thus, in both respects, the Commission's dismissal was technically incorrect, capricious, and devised without foundation.

In addition, CELSAT seeks reconsideration of the Commission's unwillingness to relax the power flux density limits. CELSAT had proposed a more modest relaxation then that requested by certain LEO candidates, and one which would apply only over the United States. (Although CELSAT requests such relaxation, its system is viable whether or not it is granted.)

Background

CELSAT's novel combination of large, high gain satellite antennas, geostationary orbits, spread spectrum CDMA modulation technology, and CELSAT's proprietary network controller allow CELSTAR to promise superior performance and more diverse functionality relative to the other L/S-Band proposals, including:

- very large system capacity (up to 61,000 space channels -- more than ten times the domestic capacity of IRIDIUM -- and several hundred thousand additional terrestrial channels;
- very low power, compact user terminals (1/5th the RF power requirements of any of the other applicants);
- superior functionality at the lowest end user charge (instantaneous position determination, compressed video and data speeds of 144 kbps or higher, narrow band messages, mobile voice at less than $0.25/min.); and,
- most importantly, extremely high spectral efficiency (up to 350% more frequency efficient, for example, than IRIDIUM, and 1000% more than any other proposed system in the space segment alone).

It is significant that during the comment phase to CELSAT's rule making petition and its request for pioneer's preference[2] no party seriously challenged the superior capacity, spectral efficiency, functionality, lowest cost, general technical feasibility, or the non-interfering characteristics of CELSAT's CELSTAR HPCN system.[3]

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[2] CELSAT's Request for Pioneer's Preference is designated ET File No. PP-28. The Commission's NPRMTD did not address CELSAT's pioneer's preference request.

[3] Two parties, Motorola and GTE -- neither of which have any technical expertise in the field of satellite antenna design or deployment -- Footnote continued next page. . .

CELSAT petitioned the Commission to, among other things, amend its rules applicable to the RDSS L/S-Bands to accommodate CELSAT's proposed *Hybrid Personal Communications Network* (HPCN) concept. The Commission has now tentatively decided to amend the RDSS rules broadly to permit new, mixed MSS/RDSS services, but in doing so it has nearly excluded CELSAT from participating under the proposed new changes. As demonstrated below, the new re-allocation of the former RDSS band is still well suited for CELSAT's HPCN use, even as a mixed use MSS allocation. CELSAT is just as capable -- in fact, more so -- of operating in conformance with the new allocation as any of the other interested candidates.

Understanding CELSAT's *Hybrid* Use of the Spectrum

In broad terms "HPCN" describes a combination RDSS and mobile satellite service (MSS) capable of ubiquitous coverage, tremendous capacity, extreme portability, superior functionality, and lowest possible cost mobile and position determination services. Under CELSTAR HPCN is, in effect, a three-tiered integrated mobile radio system anchored by a geostationary satellite-based backbone network defined by up to 149 relatively small and tightly configured space cells covering the entire contiguous United States, Alaska, Hawaii and Puerto Rico. Overlaid

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continued . . .

timidly questioned the feasibility of CELSAT's proposed 20m satellite antenna. CELSAT responded to their unwarranted criticism in its Consolidated Reply, filed on April 24, 1992, and subsequently filed a letter from Harris Corporation's Space Systems Division (copy attached) further evidencing the total soundness of CELSAT's antenna design. (See, attachment to letter from Victor Toth to Chairman Alfred C. Sikes, July 26, 1992.)

selectively over certain of these space cells (but not all) will be many mobile terrestrial subnetworks of regional cell-like and intracellular PCS-like systems. Mobile communications between and among stations within the multi-tiered satellite network hierarchy (and/or with stations on the landline public network) occurs automatically and transparently to the end user under the direction of a network controller. (In other words, no dual mode switch or other user intervention is required.)

The HPCN terrestrial mobile cell and microcell subnetworks can be operated with extreme spectral efficiency achieved by CELSTAR's unique ability selectively to re-assign small "slices" of satellite spectrum (two subbands of 1.25 MHz[4]) for limited terrestrial re-use in high density geographic areas requiring greater and more concentrated capacity, while continuing simultaneously to re-use the entire satellite spectrum allocation throughout the rest of the space cell coverage areas.[5] In effect, and contrary to the Commission's apparent prior limited understanding, satellite MSS spectrum is never fully removed for

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[4] As CELSAT points out the mere allocation of two subbands for terrestrial use in selected high density markets not only affords all the ground-based capacity reasonably required for such markets, but has only a negligible effect on the capacity of the HPCN space segment. This is because the re-use of the two subbands allocated in selected markets to ground use permits tremendous ground capacity in those space cells where such capacity is required while permitting the same subbands to continue to be reused in the space component in space cell areas where deployment of ground cells is not warranted.

[5] This describes the preferred mode of operation as set out in CELSAT's initial petition. As discussed, *infra*, and as readily apparent from a reasonably studious reading of CELSAT's initial filings, CELSAT's terrestrial component is not wedded to the primary MSS satellite allocation, but can just as well be derived in a separate spectrum allocation.

non-satellite use; instead, mere slivers of the allocation are relatively incidentally and dynamically reassigned and thereby leveraged on the ground in pockets of high density traffic while the full allocation continues to be re-used efficiently from space everywhere else.

In contrast to similar attempts to merge space and ground mobile capabilities, such as under the Future Land Mobile Public Telecommunications Service concept ("FLMPTS"), CELSAT's proposal will permit any HPCN-compatible CDMA user terminal to communicate via either a mobile satellite path, or via a terrestrial cell or microcellular path without requiring wasteful, separate and different frequency allocations to be set aside for each type of intercell or intracell communications. To the extent permitted under the Commission's rules CELSAT had hoped to achieve integrated communications between cell types in its HPCN hierarchy using only one relatively narrow spectral allocation (i.e., 32 MHz from the former RDSs L/S-Band), but at most it will now require no more than two different spectrum allocations of the same total bandwidth to achieve comparable results.

Intervening developments now call for a different approach to the available spectrum. As it has turned out, requirements growing out of WARC-92 now render at least 3-6 MHz in the 1610-1616 MHz band tentatively unavailable for MSS in the U.S. to the extent that coordination must be maintained with the GLONASS

system.[6] This leaves between 10-13 MHZ in the L Band for MSS/RDSS use on a shared basis. While this at least temporarily moots CELSAT's preferred use of this band CELSAT is still fully compatible with and capable of operating within the constraints of the new limitations, including sharing. CELSAT will look elsewhere for the spectrum needed to round out its terrestrial component, while also attending to the emerging universal and ubiquitous service needs of the now more clearly identified PCS industry -- but still in full HPCN fashion.

Thus, CELSAT's proposed HPCN is extremely flexible and adaptive[7] and, as such, it can operate effectively in several alternative configurations from a common MSS base, preferably the new 1610-1626.5 MHZ and 2483.5-2500 MHz bands. Indeed, as discussed below, CELSAT seeks rule changes which will permit it to do so. To the extent, however, that HPCN functions are divided between separate allocations (e.g., one MSS and one terrestrial mobile or PCS), it might not be necessary afterall that either allocation expressly reference "HPCN" service use. HPCN is a service concept that can be just as well attained by CELSAT using a combination of conforming uses of separate allocations within the 2 GHz band as it can be if separately and expressly recognized.

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[6] The requirements reaffirmed at WARC-92 to coordinate and not interfere with GLONASS are still subject to interpretation. As the full significance of footnote 753X and COM5/8 are better understood CELSAT's ability to avoid interference in the 1610-1616 band will be more accurately determined.

[7] See, e.g., CELSAT's Consolidated Reply, pp. 3-9.

The Commission's Partial Dismissal

In its NPRMTD the Commission, in part, dismissed CELSAT's petition insofar as CELSAT requested the reallocation of the RDSS L/S-Bands for HPCN purposes.[8] The Commission cited the following reasons:

> 1. A misunderstanding that, in general, it is infeasible for both geostationary and non-geostationary systems to "share the same frequencies," and because CELSAT has proposed a GEO system, it will not be able to share the spectrum with LEOs. NPRMTD, p. 16 and n. 15.
>
> 2. A misunderstanding that the HPCN system proposed by CELSAT would not conform to the WARC-92 re-allocation of the 1610-1626.5 MHz and 2483.5-2500 MHz bands for the United States to the extent that the HPCN terrestrial component is inconsistent with this international allocation. NPRMTD, p. 7., n. 15.

These were the *only* two reasons given in the NPRMTD for the partial dismissal of CELSAT's petition. CELSAT seeks reconsideration on each point because it believes that the Commission's action (i) was erroneously grounded on technical misunderstandings; (ii) overlooked the flexibility inherent to CELSAT's chosen technologies; and (iii) the Commission otherwise acted without basis in the docket record.[9]

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[8] The Commission did not deny CELSAT's petition to the extent that CELSAT proposed spectrum allocations in other alternative bands for HPCN. See, NPRMTD, p. 7, n. 15. It is noted that a typographical error at n. 15 misidentifies the requested alternative uplink as "2120-2129 MHz" whereas it should have been 2110-2129 MHz.

[9] In support of its understanding that LEOs and GEOs cannot share a common MSS spectrum allocation the Commission cited the activity of the CCIR Study Group 8D. CELSAT has initiated participation with this effort and, to date, believes that that committee has formed no general conclusions which would support the Commission's disposition of CELSAT's proposal.

The LEO-GEO Incompatibility Issue:

For purposes of tentatively defining potential users of the re-allocated 1610-1626.5 MHz and 2483.5-2500 MHz bands the Commission grouped the interested parties into two camps -- LEO and MEO candidates, and GEOs. The GEO camp consists of only two parties, AMSC and CELSAT. Both were tentatively denied access to the proposed new MSS allocation for the same reason, but for CELSAT the basis was incorrect. The Commission apparently believes that there exists an inherent inability for all combinations of LEO and GEO satellite systems to share the same frequencies, at least for the kinds of MSS services which the Commission intends to allow in this band. (NPRMTD, p. 7, ¶16 and n. 15.) While this proposition is true for the GEO satellite and associated antenna configuration proposed for the AMSC system, particularly when coupled with the fact that AMSC is not proposing spread spectrum modulation, it clearly is not true of the CELSAT configuration. This is because CELSAT is proposing a very high gain satellite antenna and spread spectrum CDMA modulation -- technical factors which distinguish CELSAT from AMSC and any other GEO MSS system ever proposed for commercial use.

Indeed, it has been recognized that one of the primary factors underlying the trendy international support for LEO systems has to do with the perception that only low earth orbiting satellites can service low power handsets and small ground terminals. As CELSAT has shown, this is a myth -- one which is overwhelmed by the far superior and more cost effective ability to

reach low power handsets using very high gain, very large antenna geostationary satellite systems. In due course, LEO's might prove to be too expensive for global mobile communications. Meanwhile, the unraveling of the mythical conflict involving the GEO/LEO sharing issue is detailed more technically in Attachment B to this petition.

Moreover, not a single party objected to the CELSAT petition on the grounds that its proposed geostationary satellite could not share the subject spectrum with LEO systems, or that it would otherwise interfere with the LEO's. To the contrary, in its Consolidated Reply CELSAT went to great lengths mathematically to demonstrate the complete ability of CELSAT's large antenna geostationary system to share the same spectrum band with either IRIDIUM or the other Big LEOs. (See, CELSAT Consolidated Reply, Supplemental Appendix E.) In support of its Application to participate in the negotiated rule making proceedings proposed in this docket CELSAT further supplemented its prior demonstration of technical compatibility for sharing, and went on to calculate the effects on gross domestic MSS capacity of alternative sharing schemes for CDMA-based systems, LEO and GEO combined. (See, Attachment to Comments and Application of CELSAT, INC. CC Docket 92-166, September 3, 1992.) To date, no party has challenged CELSAT's showing, its methodology, or its LEO/GEO sharing conclusions.

Thus, to the extent that the Commission categorically rejected CELSAT's proposal on the basis of a generalized and

therefore incorrect assumption as to LEO/GEO incompatibility (an assumption which might have arisen in the context of AMSC's request for access to the RDSS spectrum) its decision is technically unsupportable and unfair. Accordingly, the Commission should reconsider and reinstate CELSAT's petition for HPCN rule changes in recognition of CELSAT's undisputed technical ability to share the proposed new MSS spectrum with the low earth orbit systems under many possible sharing schemes.

The WARC-92 Issue:

The second and apparently more significant reason for partially dismissing CELSAT's petition as to the RDSS L/S-Bands was based on the Commission's perception that CELSAT's proposed HPCN use of the subject band would be inconsistent with the re-allocation of this band at WARC-92 for the United States.[10] Here, too, CELSAT submits that the Commission's basis is incorrect and arises from an incomplete understanding of the CELSAT HPCN system, and out of intervening WARC-92 developments which can now be overcome by a simple clarification of CELSTAR's capability.

As discussed above, CELSAT's HPCN operates first, foremost and always as a satellite-based mobile and position determination service. In its preferred configuration every hertz of the spectrum originally requested by CELSAT would have been used for space-based satellite HPCN communications at all times in many, if not most, of the CELSAT space cells across the country. In

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[10] **See, NPRMTD, p. 7, n. 15.**

this mode and under any reasonably contemporary interpretation of the concept of "MSS", CELSTAR would qualify as a user of the full spectrum allocation for MSS purposes notwithstanding its HPCN capability.[11] Again, as originally proposed and without sharing, one or two selected subbands within the requested allocation were proposed only for limited and local re-assignment by CELSAT in certain high density geographic areas of the country to attain still more efficient use of the spectrum for terrestrial-based cell and microcell communications. This planned re-use would hardly amount to more than a minor deviation from the now principally intended MSS use.[12] Considering the predominant role of the satellite backbone network to HPCN, any allocation for MSS with permissible RDSS use, such as proposed in the NPRMTD, is not only equally appropriate for CELSAT as it is for the LEOs, but totally consistent with CELSAT's HPCN concept as originally proposed.

CELSAT now recognizes that, irrespective of the WARC-92 re-allocation for MSS, given the new requirements for continued

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[11] If such re-use appears to be inconsistent with the prevailing narrow, traditional industry perception of what makes up an eligible "mobile satellite service", then CELSAT submits that the industry ought to begin adjusting to a more contemporary view of "MSS" consistent with today's technology.

[12] Importantly, even as to the two subbands which would have been partially reassigned in high density areas for terrestrial use the user terminals communicating with the terrestrial based cells and microcells will still be in partial one-way communication with the space segment over the same subband spectrum to the extent required of the pilot signals and network controller.

Thus, as a technical truth, all HPCN subbands would be functionally operating in an MSS mode *in full conformance with the new WARC-92 re-allocation albeit* only for station control purposes, even while a subband is being used within a selected space cell for carrying the non-control information signals terrestrially.

GLONASS coordination and the Commission's commitment to multiple entry in this band on a shared basis, as a practical matter the full 16.5 MHz in the L-Band will not be available. CELSAT is prepared to adapt accordingly, just as the other candidates will be required to do. Specifically, in this environment CELSAT will effectively abandon any use of the new MSS allocation for terrestrial purposes. Instead, it will identify and request access to about 6-9 MHz of alternative spectrum in the 2 GHz band suitable for either both space and terrestrial mobile use, or at least for terrestrial HPCN use only.[13] Spectrum from such a new (or an existing) allocation in another band will then be used in conjunction with CELSAT's pro-rata shared allocation derived as a fully conforming participant in the new MSS band to complete the terrestrial component of its hybrid service concept.[14]

In summation, CELSAT's HPCN will conform with the WARC-92

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[13] Even without a separate terrestrial component, as an MSS licensee in the new MSS band CELSAT could still operate as the only true "hybrid" system. This can be achieved by deploying access to its network controller and compatible handsets to participating PCS licensee end users in the Emerging Technologies bands proposed in ET Docket 92-9 and Gen. Docket 90-314. To the extent CDMA-based PCS systems are authorized in the 2 GHz band they can be made compatible with CELSAT's HPCN operating in the proposed new MSS band. Such operation will be automatic, transparent to the end user, would not require dual mode switching, and would ensure PCS users ubiquitous, nationwide coverage outside their base system areas. In contrast to any other candidate in the MSS band, only CELSAT has the potential capacity and low cost structure to make such an accommodation to the PCS industry both feasible and economically attractive.

[14] While noted above that CELSAT will be able to service the emerging PCS market on the MSS allocation for satellite communications, it would still be technically and economically important for CELSAT to pursue the fully complemented nationwide terrestrial cellular and microcellular system for which it is best designed. Not to do so would be a terrible waste of a vast infrastructure capability and spectrum resources which, for the price of substituting a mere 6-9 MHz of HPCN-compatible spectrum outside the new MSS band, could effectively replicate on a wireless basis the communications port capacity and much of the functionality of either of the nations second or third largest wireline interexchange carriers.

is free to deviate from WARC recommendations where there is good reason to do so and no conflict with international regulations will result. CELSAT submits that its HPCN concept offers every possible good reason for such a deviation and no conflict will arise. For the time being, however, for the reasons related to sharing and to GLONASS mentioned above, CELSAT will use the new MSS allocation *only* for satellite communications, and will obtain its terrestrial component elsewhere. Therefore, the Commission's basis for denial under the outcome of WARC-92 does not apply and CELSAT's petition should be reinstated.

Power Flux Density Issue:

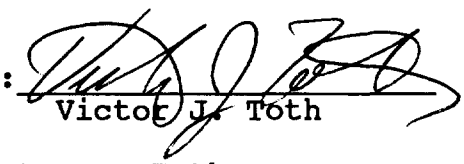
Although it went unaddressed in the Commission's NPRMTD, CELSAT also requested a modest relaxation of the power flux density limits by about 6 dB as they would be applied to the 2483.5-2500 MHz band under Radio Regulation No. 2566. (See, NPRMTD, p. 7, ¶¶20-24.) While the Commission expressly rejected the proposals of others to relax PFD by 10 dB, due to the confusion created by resolution COM5/8 in the WARC-92 Final Acts it is still not entirely clear to CELSAT where current events leave the power flux density issue. However, considering that CELSAT's request is more modest than that rejected in the NPRMTD and would only affect coverage over the United States, CELSAT urges the Commission to

reconsider this matter and at least grant the more limited relaxation over the United States as requested by CELSAT.[16]

CONCLUSION

Accordingly, for the foregoing reasons, CELSAT respectfully requests the Commission to reconsider its partial dismissal of the CELSAT petition and add to its proposed new MSS allocation an express rule provision permitting conforming use of the 1610-1626.5 MHz and 2483.5-2500 MHz bands for HPCN systems using geostationary satellites, provided such systems are capable of sharing the spectrum with other compatible licensees in such a way as to avoid conflict with the WARC-92 re-allocation of the former RDSS L/S-Band for Region 2.

Respectfully submitted,

By: 
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October 5, 1992

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[16] See, CELSAT Petition at pp. 33-35.

HARRIS

ATTACHMENT A

08 July 1992

Celsat Corporation
532 South Gertruda Avenue
Redondo Beach, CA 90277

ATTN: Mr. David D. Otten
President and CEO

Dear Mr. Otten:

Thank you for visiting Harris to discuss the Celsat system. The meeting and a subsequent review of the Celsat filings and briefing materials provided valuable insight in how Celsat and Harris might benefit from working together. We were impressed with your approach of using a hybrid system to meet the near and far term market opportunity. The efficient use of spectrum achieved by combining CDMA with Celsat's network controller and large antenna design provides the basis for a sound technological approach with several benefits.

As you could see from our presentation, Harris has the capability and experience to design and build your antenna and payload. We were pleased to see your baseline approach of using a 20 meter deployable antenna. We believe this approach offers an optimum mix of service capacity and functionality.

As you are aware, some companies have been hesitant in using large deployable antennas. This can be attributed in part to their lack of awareness of the current status of this technology. Since the start of the Tracking and Data Relay Satellite (TDRS) program in the early 1970's, Harris has been building large deployable antennas for space. This program (with over 8 antennas currently on orbit) is the foundation of our capabilities in deployable antennas.

In the mid 1980's, Harris built and tested a 15 meter diameter deployable antenna that operated up to 12 GHz for NASA's Large Space Structures Technology (LSST) program. This program proved the viability of large spaceborne deployable antennas. In fact, this approach can be used for antennas as large as 150 meters in diameter. Harris also built for NASA a 60 foot diameter optical reflector for the Solar Concentrator Advanced Development (SCAD) program. These programs provide the experience and expertise necessary to build a low risk deployable antenna that operates at less than 3 GHz.

Combining technology that is frequency efficient with mature technology to optimize cost and functionality represents a sound approach. Harris looks forward to expanding our working relationship with Celsat. If you have any questions or comments, please contact Mr. Mike Moeller at (407) 729-7141 or myself at (407) 727-5809.

Sincerely,

Dr. Bill C. Tankersley
Director, Space Systems

BCT/bam

END

ATTACHMENT B

LEO-GEO COMPATIBILITY

In its August 5th Notice (Docket 92-28 on page 7), the FCC has explained part of its decision not to include CELSAT in the RDSS bands on the basis of the fundamental incompatibility of LEO and GEO systems. We would argue that the issue of LEO-GEO compatibility requires a fresh reexamination on the basis of the CELSTAR development.

First we note that the issue, if any, of band sharing compatibility between LEOs and GEOs is *not* on the downlink for the following reaswon: Given that all the current generation of mobile satellites are designed for essentially omnidirectional subscriber unit receiving antennas, and since all have roughly the same required Eb/No and data rate, it follows that GEOs or LEOs all require about the same ground level *flux density* per user on the user down link for satisfactory performance. So that on the down links, LEOs and GEOs are inherently on a levelled basis with respect to band sharing capability.

The uplink is a different matter. The first proposed Mobile satellite (now AMSC), utilizing **GEO**synchronous orbit required relatively high user unit antenna gain (to 12 dB) and EIRP (to 21 dBW) to support high grade voice. Later, **LEO** proposals showed it possible to support high grade voice with omnidirectional antennas and much lower subscriber unit EIRP of the order of 0 to 3 dBW.

Clearly there was an uplink band sharing incompatibility between two such systems. The proposed LEO systems were able to operate with much more desirable omnidirectional user antennas, and at subscriber unit EIRP some 20 dB smaller than the proposed GEO. Band sharing of such systems with GEO (as represented by AMSC), however, appeared almost impossible. The LEO uplinks in particular would be quite vulnerable to the 20dB or so larger subscriber unit EIRP from the AMSC system. It was natural to associate this power discrepancy and band sharing incompatibility with the range disadvantage (some 15-30 dB) of GEO as compared to LEO systems and to regard that advantage as generically inherent to the LEO and GEO concepts.

What the CELSTAR development has now shown, however, is that such subscriber unit EIRP discrepancy is *not* inherent to all GEO systems, but rather, particular to the older AMSC design. The CELSTAR design *more than overcomes the range disadvantage of synchronous orbit by very high satellite antenna gain, practical only at geosynchronous orbit.*

The reasons for this can be seen from the up-link budget equation for the received Eb/No:

$$\frac{E_b}{N_o} = \frac{EIRP_{user}\ G_{sat}\ \lambda^2}{(4\pi)^2\ R^2\ \ kT_sR}$$

which may be rewritten as an equation for the required user unit EIRP in terms of required Eb/No:

$$EIRP_{user} = \left(\frac{4\pi}{\lambda}\right)^2 \left(\frac{E_b}{N_o}\ kT_sR\right) \left(\frac{R^2}{G_{sat}}\right)$$

The first term on the right is a constant, and the second doesn't vary a great deal between reasonable current designs. There is relatively little a designer can do to reduce Eb/No or Ts or data rate, R, below those assumed by all the current competing MSAT proposals. So one would anticipate that in an efficient design, subscriber unit EIRP should be generally proportional to R^2/G_{sat}. This is shown to be roughly the case in the following comparison table:

TABLE 1

SYSTEM	R km	$G_{sat}(R)$ dB	$R^2/G(R)$ dB (rel)	DESIGN EIRP dBW
AMSC	36000	33.8	14.6	21 (Toll Quality)
MOTOROLA	1644	17.5	4.1	6.9 (Peak Pulse)
ELLIPSAT	1250	8	11.2	.3
LORAL/QUALCOMM	1390	3	17.2	.3
TRW	12800	25.4	14.0	-.5
CONSTELLATION	1018	-2	19.5	1.0
CELSAT	36000	48.4	0.0	-9.0

This shows that the differences in subscriber unit EIRP are, as one would expect, largely explained by the parameter $R^2/G(R)$. AMSC stands out from this comparison because of relatively less efficient coding and modulation and MOTOROLA because of the high peak power resulting from use of a low duty cycle Time Division Duplexing structure. The important thing here with respect to compatibility is that CELSTAR, the only current design GEO system in this comparison, stands out as having the *lowest* subscriber unit EIRP. We view this as not being *in spite* of the GEOsynchronous altitude,

but rather because of the even more important high satellite antenna gain made prctical by stationary orbit.

* * * * *

CERTIFICATE OF SERVICE

I, Victor J. Toth, hereby certify that a copy of the foregoing document was served by first-class mail, postage pre-paid, this 5th day of October,1992 on the following persons:

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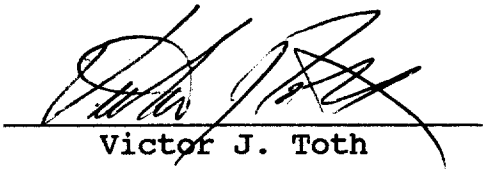

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